An Indigenous Automated GupChup Machine

A Thesis Submitted In Partial Fulfilment

of the Requirements for the degree of

Bachelor of Technology
In
Mechanical Engineering

By

Prakash Sarangi
Roll no: 110ME0329

Department Of Mechanical Engineering
National Institute Of Technology Rourkela
Rourkela-769008
Orissa, India

An Indigenous Automated GupChup Machine

A Thesis Submitted In Partial Fulfilment

of the Requirements for the degree of

Bachelor of Technology
In
Mechanical Engineering

By

Prakash Sarangi
Roll No: 110ME0329

Under The Supervision Of

Dr. Subrat Kumar Panda
(Department Of Mechanical Engineering)

Department Of Mechanical Engineering
National Institute Of Technology Rourkela
Rourkela-769008
Orissa, India

National Institute of Technology, Rourkela

CERTIFICATE

This is to certify that the work in this thesis entitled "An indigenously made automated GupChup Machine" by Prakash Sarangi, has been carried out under my supervision in partial fulfillment of the requirements for the degree of Bachelor of Technology in Mechanical Engineering during session 2013-2014 in the Department of Mechanical Engineering, National Institute of Technology, Rourkela.

To the best of my knowledge, this work has not been submitted to any other University/Institute for the award of any degree or diploma.

Dr. Subrata Kumar Panda

(Supervisor)

Assistant Professor

Department of Mechanical Engineering

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to the Project guide Prof. Subrata Kumar Panda for his innumerous contribution made towards the project and supporting for this project from the time of its inception.

I would like to thank Ms Pramanik for helping us in arranging financial assistance in the Project via TEQIP-II and ensuring that the project doesn't fall through due to lack of funds.

I appreciate the great unconditional support given to me by Prof. S.S. Mohapatra. It is due to him that I could explore more about the characteristics of rapid prototyping to speed up the work in developing the automation.

I appreciate the full-fledged support extended by Prof. Saroj Kumar Patel. His allowance has helped me work in the workshop in the late hours in the workshop while developing the machine.

I would appreciate the great moral support and encouragement given by Prof. Suraj Kumar Behera, Prof. Anirban Mitra and Prof. S.C.Mohanty. I would also like to appreciate the guidance given by Prof. Sunil Kumar Sarangi and Prof. S. Murugan.

I shall always be grateful to Swayam Bikash Mishra, Arbind Khuntia and the staff of carpentry as well as welding workshop for spending their valuable time in helping me fabricate the experimental setup. I would like to specially mention Dhyanchand Jani, Kanhu Charan Biswal, Avanish Maurya, Kartikeya singh jodha and T Satish Kumar for their times they had come with me in the workshop to help me fabricate the experimental setup.

This Project would also not have been completed had Amiya Samantray, Praseed Sahu, Navin Kumar, Kaushal Kishore, Shaikh Tariq Mobin and Sandeep Mishra not been there for helping me in making this dream come true.

Finally, I would like to thank my classmates, other colleagues and entire college environment for their support and entrusting us with the project and finalizing this project within the limited period.

Prakash Sarangi

Roll No. – 110me0329

TABLE OF CONTENTS

Abstract

Today automation has been an integral part of the food industry as concerns over health and safety have increased worldwide. In this paper, we take up a simple local food delight of India, The GupChup, and design a product that can automate its making process to ensure that the best taste is available to its consumers without concerns over health or safety. The product is designed to take input of Puris, boiled potatoes, spicy water and required spices and ultimately produce the GupChups. The automation ensures that the job is done faster, safer and skill independent. In addition to it, attempt has been made to ensure that standardisation of GupChup Making process is made such that the taste of the GupChup is conserved and ensured every time for the consumer. A study of automation processes available has been made to develop an automation that fits the purpose. The final evaluation has been made after experimental procedures to produce the required automation.

List of Figures

16. Analysis for 2.5kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

17. Analysis for 3kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

LIST OF TABLES

1. Introduction:

Present food habit has been changed in many aspects around the globe owing to the exchange in cultural, social and economic paradigm change. GupChup (spice mixed potato stuffed fried dough/Puris with colored water) is a very popular street snack that has stood the test of time and location. Nevertheless of its wonderful taste or popularity, the real commercial value of this indigenous food item has never been realized due to several ills like hygiene, unstandardized composition, involvement of skill, etc. In addition to it, unhealthy manufacture practices, improper storage facility and unstandardized composition has been continuously diminishing its popularity since their quality standards vary from Zenith to Nadir. This popular street item still hasn’t reached to several corners of India, let alone the world, since skill is involved which is also a factor influencing taste of GupChup.

Thus we intend to design, model analyze an indigenously made Automated GupChup Machine that automates the GupChup serving process, stores the food items against any weather condition, keeps GupChup healthy, can be used anywhere with power availability, standardizes the process and enables the customer to customize his GupChup.

We intend to study various automated systems that are available and relevant work done in that field. This would be succeeded by continuous simulation modelling and analysis of the designed system. Analysis shall be done both by analytical as well as experimental procedures.

2. Aim of the Present Work:

We intend to design an automated GupChup machine that automates the manual work done by a GupChupwalla. We try to make an automatic wending machine that ensure hygiene, standardized quality and optimum time consumption. It shall take in raw material of boiled Potato, Colored water, Spices and Puri as input. A consumer fed token that begins the machine and an output of 1 set is obtained per token. Each set shall consist of 4 GupChup and 1 glass of Colored Water. 4 GupChup is made of 4 Puris, 1Boiled Potato mixed with certain Spices. We have broken down the complete functioning of the system into subunits:-

1) Design of a system for discrete GupChup and potato transfer

The discrete GupChup and Potato transfer is intended to work as a counting mechanism and by that mechanism it intends to count 4 Puris and 1 boiled potato; and transfer GupChups and Potatoes to other system via an integrating mechanism for further processing.

2) Design quantised Masala transfer

All the masalas are calculated by Arduino Programming based on the selection criteria put forward by the user. The system must then be able to transfer the masala from the storage tanks to the mixing center.

3) Design of Masala Maker and filling mechanism

A Masala Mixture mechanism has to be designed that semi-mashes the boiled potatoes from one system and mixes the spices with it. The Masala thus made is then filled into the Puris.

4) Design Interface and Integrate systems

A system must be designed that can work between each individual systems and transport the respective food item from one to the other. Finally the production system is expected to finally get the item after processing at each system to the final delivery.

3. Literature review

The Design of machine elements is an intricate part of mechanical engineering and is a highly essential tool in developing mechanical systems. Khurmi and Gupta [1] has jotted down several rules, criterions and guidelines for the design of various machine elements.

Companies like Nescafe [2] and Le Cube [3] are pioneers in the field of wending machines. Their automatic beverage generating machines have been popular ever since its conception. Their service manual describes the work and the intricacies that have been laid down inside the small machine to produce the required automation in developing the food item.

Mechanical counting in a Gumball machine has been proved to be most effective and has similar features as our problem statement. Several work has been done by inventors and designers over the years in producing variable tweaks in providing a perfect mechanical counting of the Gumballs. Since our requirement is highly basic, we find the work done by an internet blogger Steve Hoefer [4] working for Grathio Labs as most informative and as well as enlightening. He has explained in a project a simple way by which the gumball machine would work by the use of grooved cams.

The inception of the idea for the automated GupChup machine is seeded by the need of saving a popular street snack from the unhygienic conditions in which it is prepared. A documentary on the issue has been made by Tv9 Gujrat [5]. The issue given there has been taken up by Ankit Kareliya *et al*. [6] to develop a semi-automatic Pani Puri Machine which takes a little human intervention and produces the GupChup.

4. Methodology:

1. Study of systems and works done

The existing automated machines like Coffee machines are to be studied to understand the automation mechanism. All relevant mechanisms and papers in the field of food storage, design and production needs to be studied. Documentaries on food threat are to be seen to understand the criticality of the case being worked upon. Mechanisms and available options are to be searched from the Internet.

2. Design and simulation model of the apparatus

With the help of 3d modelling software the design and simulation of the components shall be done at each stage.

3. Analyze via analytical and experimental processes

Structural Analysis modules of ANSYS 13.0 shall be envisaged for the analytical process to find the results via Finite Element Analysis (FEA) method.

Experimental setup shall be made and the design shall be analyzed by experimental methods as well. Various critical components demand experimental analysis for improvement as well as suggestions. Thus data from experimental processes shall act as solid foundation to analyze the feasibility of the design.

4. Return to Step 2 if optimum result is not obtained

All the results after analysis both by analytical and/or experimental processes shall be checked for feasibility. If optimum results are not obtained, the design and analysis process shall be repeated.

5. Schedule of the Work:

Sl. No	Activity	Estimated Time	Activity Breakup #Each box represents a unit of 2weeks
1	Study of Systems and Works	6 Weeks	
2	Design of system	30 Weeks	
3	Material Procurement	28 Weeks	
5	Numerical Analysis	40 Weeks	
6	Experimental Analysis	36 Weeks	

6. Observations and Calculations

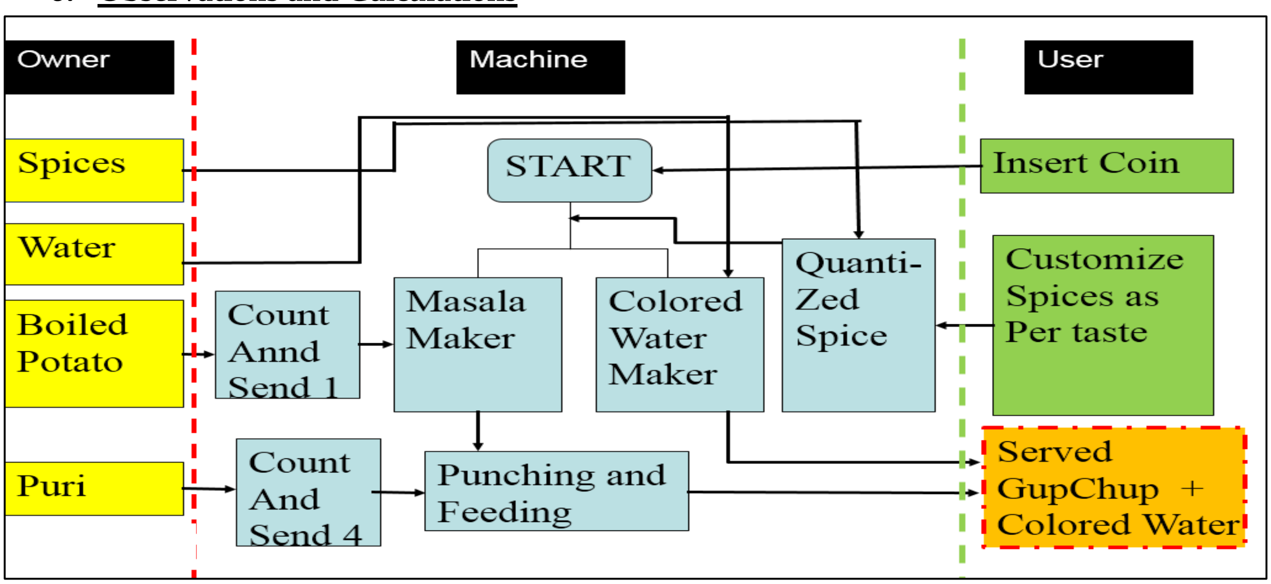


Figure 1Process Layout

6.1 Design of Masala Maker

Inputs: 1 Boiled Potato and Spices as sent by quantized spice

Outputs: Masala

A hopper is designed to allow the flow of potato and thereby create the masala by the time it reaches the transfer part. We need to design the hopper before we enter much further into Masala making.

6.1.1 <u>Hopper</u>

Inner diameter is taken to be 15 cm. Since the masala should always be less than 3cm which is the maximum length of diameter of hole in the Puri where masala is stuffed in, we keep the lower diameter as 3cm. The height of the hopper thus is kept at 15cm to maximize material flow.

The thickness of the hopper is kept to be 1cm to ensure proper thickness required for mechanical crushing of the boiled potatoes.

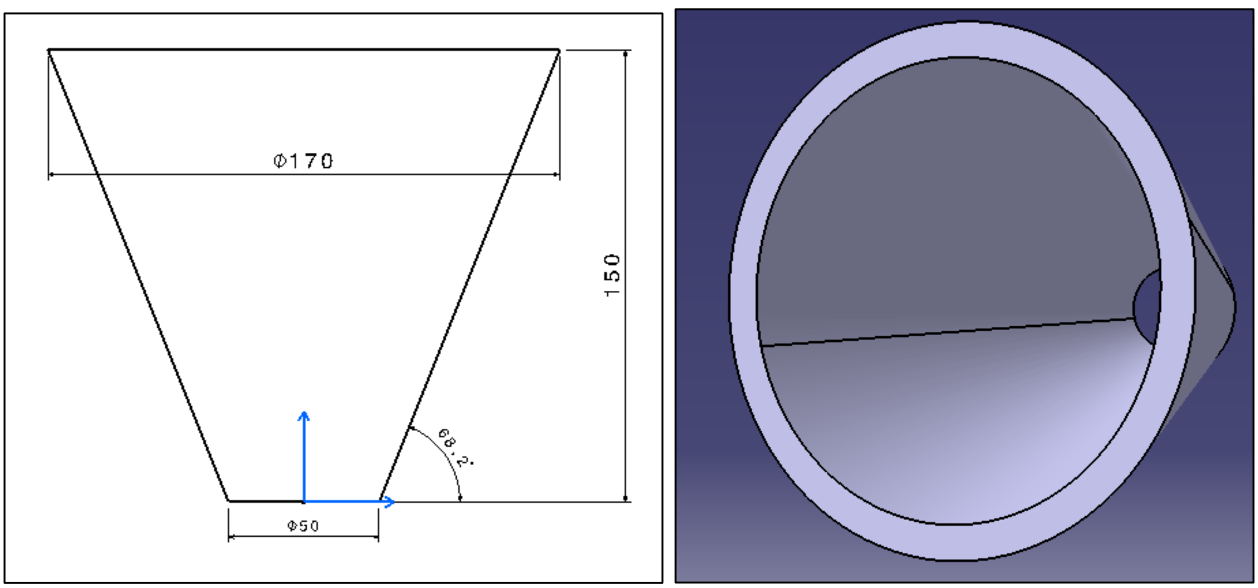


Figure 2 Hopper design. Left: Front view of Hopper (dimension in mm) Right: 3d model view

6.1.2 Blade Profile Design

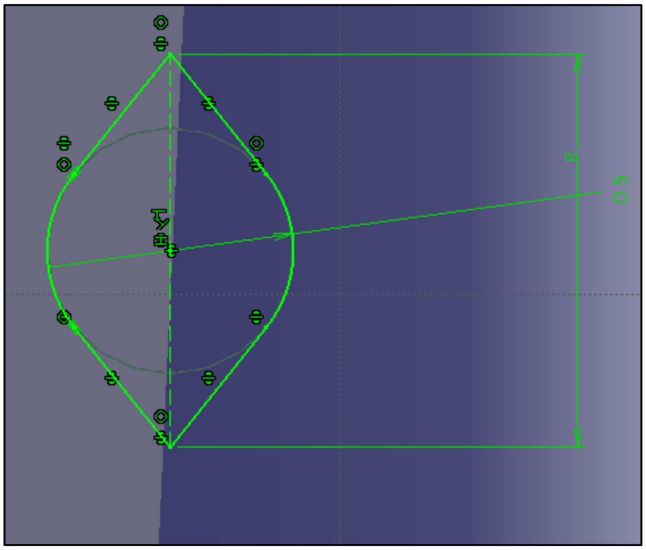


Figure 3 blade profile design

Several designs and options available at hand were keenly observed and tried. A major criteria that we observed is that the masala that comes out of the maker must not be completely mashed which makes use of existing grinder and mixing option useless. Our design should be such that the masala must consist of semi mashed state of the boiled potato with the mix of the spices. More mashing would make the potato completely sticky and devoid of any taste. Thus losing its value.

Since the major function of our blade would be mashing with minor cutting to ensure the mixing. We design a convex shaped cross section and the profile is swiped throughout a helical path keeping along the tangents to give us our desired shape. The pointed edges at the top as well as the bottom will help in the cutting of potatoes while the budged center part will help in mashing the potato with the hopper.

6.1.3 Blade Path

Range of Pitch: from 4.5cm radius to 0.5 cm radius

We have kept a gap of 3cm at the top and 2cm from the below for clearance. Thus 4cm radial distance is to be covered in 10cm height. Going spirally down to ensure that the potato is mashed at each stage as it reaches the bottom.

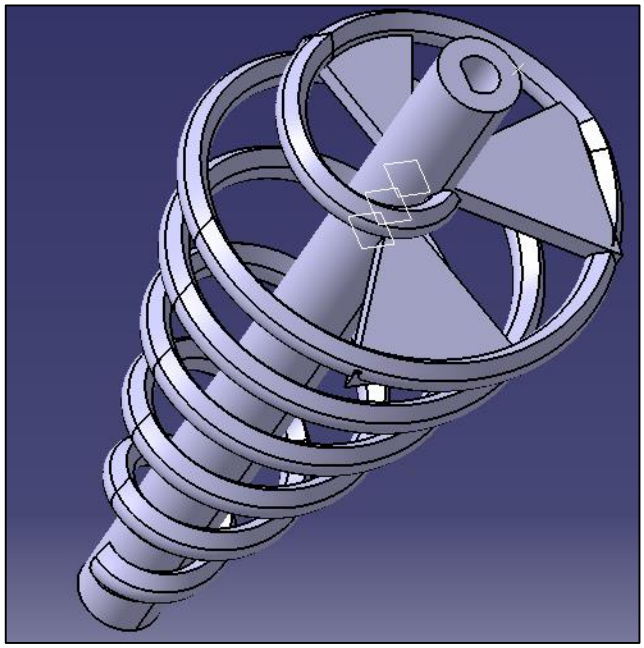


Figure 4: 3d model of blade

Trouble Shooting: It was seen that the potato has the probability of getting inside the blade and prevent its mashing up. To prevent this blockades were made. Though this problem was solved, it was seen that due to lack of support. The spirals used to spread apart when the boiled potato passes through. Due to this wooden support was put in between the central shaft and the spirals and in regular intervals to allow the mashed potato to mix completely and provide support during the lateral crushing which is required.

6.2 <u>Design of Masala transfer</u>

We find that an average hole of a GupChup is nearly 25mm with a tolerance of 2mm. So we need to design a masala transfer mechanism that transfer masala that comes out from the Masala maker to the Masala punching and feeding mechanism that inserts it into the Puris. We make a spider type arrangement to swipe the masala from one point to another inside the cover plates.

Cover plates are designed to retain the masala while it is being transferred from the Masala Making output to the feeding and punching mechanism.

Input: Masala from Masala Maker and Punch from feeding and Punching mechanism.

Output: Punch from feeding and punching mechanism.

6.2.2 Design of Upper cover plate, Lower Cover plate and Spider

The upper cover plate should have 2 holes kept diametrically opposite. An optimum size and loss of material is observed in a circular cross section. Hence circular cross section is made for the same.

It is assumed that by the action of gravity, masala after being made from the masala maker would get through the upper cover plate via one of its hole. The spider will thereby swipe it to the feeding and punching mechanism. Since there is only one output, so the lower cover plate shall have only one hole and that too needs to be concentric with the similar hole of the upper cover plate to allow the smooth punching mechanism. The holes are to be kept at a distance of 1.5d from the circumference.

Expected hole in Puri of Gupchup = 3cm (max)

Distance between the center of the hole and circumference of the cover plates = 4.5cm

Thickness of the cover plates is given 1.5mm due to material availability options.

The blades of the spider have been given a circular section to make it able to cusp the masala and put it directly into the holes. The Spider consist of bush whose width has been kept at 10mm since it is the nominal distance set to be kept between the plates so that the required volume enters into the gupchup. Keeping a 2mm clearance from the periphery the blades are thus made of length of 68mm.The bush is connected to a cylinder of 20 mm which is used to house the motor driving it.

It has been experimentally observed that the density of masala (boiled potato with spices) was found to be 1086kg/m^3. Since we will be taking 1 boiled potato for the mashing and mixing.

So the net mass of the masala would be nearly 75g (69g+6g). With the factor of safety we take the max mass of the masala as 100g.

The weight of masala = (100/1000)*9.81 = 1N (approx.)

Power of the 12V DC 60rpm motor to the blades = $\frac{12*60}{1000}$ = 0.72 W

(As per specification of the motor at no running speed 60mA current is used)

Torque transmitted by the 12V DC 60rpm motor to the blades (T) = $\frac{0.72*60}{2\pi * 60}$ = 0.1146 Nm

Weight of the blades (F_1) = ρ_A * A_1 * g = 1040 * 68 *10 *1.5*9.81*4= 0.0379

(ρ_A = density of ABS plastic, A = area of cross section of blade which owing to its thin size is approximated as a cuboidal block, g = acceleration due to gravity)

Weight of the bush (F_2) = ρ_A * A_2 * g = 1040 * $\frac{\pi}{4}$ (40^2*10+20^2*10-6^2*20)* 9.81 = 0.1383N

(ρ_A = density of ABS plastic, A_2 = area of cross section of bush, g = acceleration due to gravity)

Let F_3 be the force obtained at the blades to push the masala.

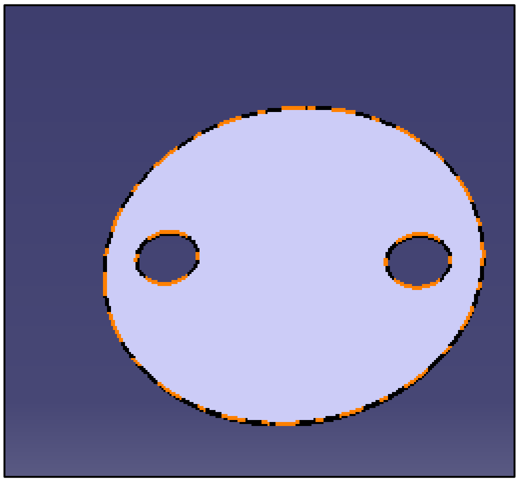
$T = F_1 * r1 + F_2 * r2 + F_3 * r3$

(r1, r2 and r3 are their distance from the axis of rotation respectively)

$0.1146 = 0.0379 * (0.088-0.020) + 0.1383 * 0.02 + F_3 * 55$

F_3 = 2N (approximately)

Since the whole masala is of 1N we have sufficient force available at the blades to move it. We also find that since our whole masala will be fed inside 4 GupChups i.e. each gupchup shall have 0.25 N of masala to be stuffed inside. It is highly convenient for each blade with a capacity of 0.5N to push it from one to the other end.



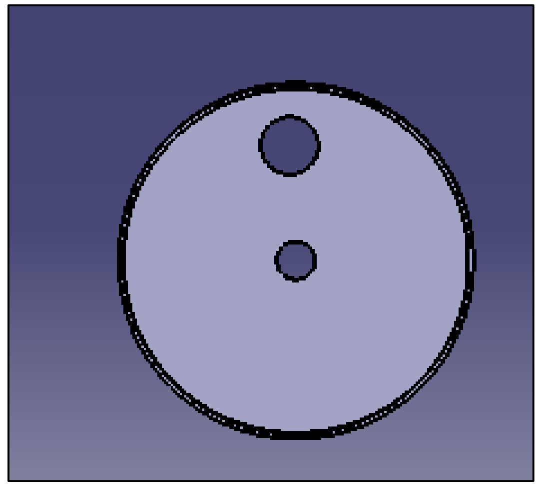


Figure 5 Left: 3d model of upper cover plate. Right : 3d model of lower cover plate

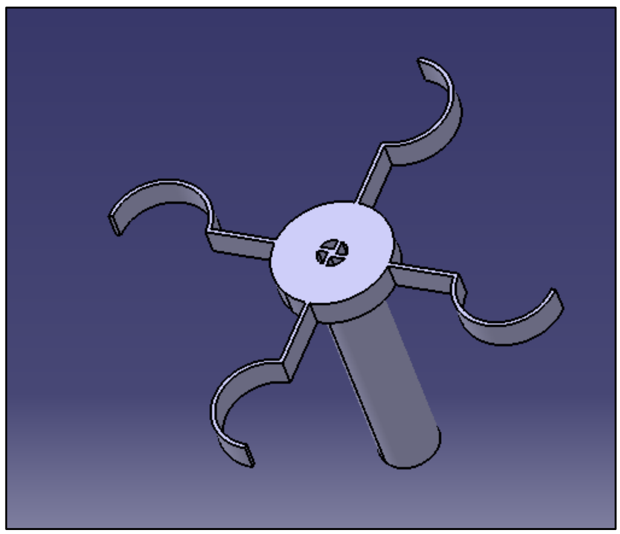


Figure 6: 3d model of Spider

6.3 Design of Punching and feeding mechanism

We have used quick return mechanism for the punching of the masala through the cover plates so that it enters into the Puri and we would be attaching a piercing object along the drive so that we could make a hole in the same time while the punching action is being done.

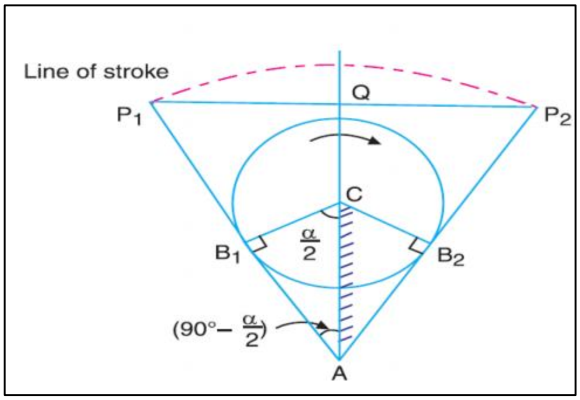


Figure 7 Quick return mechanism

The advantage of this method is that we get a quick forward stroke. One must notice that the path P_1 to P_2 which is the path of the link undergoing quick return action is a curved one while we need a linear one. To ensure its linear motion we use the 2 methods

1) Provide a slot in the 2nd link (AC) to allow the linear translation and adjustment of AP1
2) Provide a guide to the punch which shall be attached to the upper cover plate so that there is no extra linear translation and the stroke will work on a straight line.

Table 1 Physical characteristics of different Puri available

Sl.No	**Diameter Length**	**Maximum length**	**Weight**
1	5	3.5	0.004
2	5	4	0.004
3	5.5	3.5	0.004
4	4.5	3	0.003
5	5	4	0.003
6	5.5	4	0.004
7	5	3	0.004

Since an average height of the Puri is 5cm. We design our Quick return mechanism with a punch height of 5cm to include the clearances and provide a good hole as well as to punch the masala through the cover plate region.

Thus stroke length = 5cm.

Length of link = 7.5cm and the α angle is 142 degrees.

Length of stroke $= 2* \frac{Length\ of\ link*Diameter\ of\ Rotor}{Diameter\ of\ fixed\ point\ to\ centre\ of\ Rotor}$

$= 2* \frac{AP1*CB1}{AC}$

So, $50 = 2* \frac{AP1*30}{90}$

AP1 = 7.5cm

We give a 10% clearance. Thus we have the length of the slotted link as (7.5+0.75+0.75) = 9cm. We have 2 slots in the link: 1) The slot wherein the rotor will move and thereby cause the functioning of the quick returning mechanism 2) The slot wherein the stroke link will move to adjust its motion while converting the overall motion from circular to translational.

Since the diameter pf the disk is taken as 3cm. So the longer slot is kept at (30+6mm) = 36mm gap. We should keep in mind that 6mm is the standard size of bolt that we are using. The length of the smaller pin is thereby (6+6) = 12mm.

$\frac{Time\ of\ Return\ stroke}{Time\ of\ Forward\ stroke}$= (360- α)/α = 1.53

Thus this concept is known as quick return mechanism since the return stroke is completed within a shorter time as compared to its forward stroke. Since we know,

Total displacement = 2* Length of stroke = 100mm

To have a proper motion we take 10mm extra. Thus we have the length of the 2nd link as 110mm. A piston is connected at the end of this link having a height of (50+5mm) = 55mm

Since we have just one system that does the punching as well as feeding. We intend to connect the 2nd link with a C clamp to cause the simultaneous action of punching and feeding.

It is observed that if a single punch is applied to break the Puris, there is a very high chance that the whole Puri is crushed under the force and thus damaging the Puri as well as hindering the process.

Thus we fix several needles on the periphery of a ring type structure and allow it to fall and make several small sized holes in the Puris. Thus when the punch punches the masala through the cover plates, it gets down and by virtue of its weight, it easily slides down into the Puri and thereby feeding it.

As we have kept the size of holes in come plate as 3cm.

Diameter of the ring = 3.5cm

Height of the ring = 3cm

Length of Pin =4cm

Height of the Punch = Length of Pin =4cm

Since we need the joining via C clamp. We join the C clamp at the the middle of the link i.e. at 55mm.

Length of the link = Distance of the lower plate as measured from the Quick return mechanism+ height of the Punch + height of the funnel – clamp distance

= 160+40+20-50

= 170mm

The rotation of the spider must be in synchronization with the punching and feeding mechanism. Since one rotation of the spider would require the puncher to work for four times, the rpm of rotating disc must be 4 times that of the rpm of the spider. We have chosen a motor of 200rpm and 60rpm for due to market constraints and are run at 120rpm and 30rpm for rotating element of quick return mechanism and spider respectively.

6.4 Colored water maker

A special preparation of colored water is already made and loaded into the system. Flavored colored water is made by mixing water with spices and is kept at a storage tank. This is operated by a solenoid valve which allows the flow of liquid through the solenoid. The colored water is thus separately served which then depends on the consumer how he/she wishes to use it.

6.5 Mechanical Counting

Mechanical counting is a tedious process wherein a particular substance has to be counted as per the design requirement. In order to meet our objective, we take a set of 4puris that are to be filled with the Masala made by 1 boiled potato. Thus a set of counting must allow the entry of 4puris and 1 boiled potato in the system.

6.5.1 Puri Counter

As we had seen in Table 1. The average diameter of Puri was 5cm. So we assume a space of 5cm to be taken by Puri, any clearance could be adjusted by varying the size of the Puri stack and maintaining the distance. We are following the gumball mechanism and we first design a grooved disk.

The size similar to a gupchup is removed from the disc so that the Puri could easily be put in and without much further disturbance could move along till its falls down by virtue of its orientation. The thickness of the disc is kept at 80% of the max thickness of the puri to prevent it from toppling off and falling into the side spaces. To prevent very close pocket intersections and weaken the webbing, the overall diameter is kept at 15cm.

The sharp edges at the corners are provided with a small fillet of radius 5mm to prevent its sharp edges from breaking the light puris while counting them or separating them from the stack. A smooth contour ensures easy inflow and outflow of the puris.

A 6mm diameter hole is made for the insertion of DC geared motor.

Table 2 Observation of rpm values that suit the functioning of the discrete Puri counting

Sl. No	**RPM of motor**	**Observation**
1	200	Very fast, breaks all
2	100	Still very fast and breaks all
3	50	Moderately fast, breaks a little
4	40	Speed is considerable. Puris are occasionally broken
5	30	Speed is good. Breakage of Puri has highly reduced
6	20	Speed is best. Least breakage.

6.5.2 Boiled Potato Counter

Table 3 Physical characteristics of different boiled potato available

Sl.No	**Diameter Length**	**Max width**	**Weight**
1	6	3.8	0.065
2	7	3	0.068
3	8	3.5	0.07
4	6.5	3	0.062
5	7.5	3.5	0.068
6	8	3	0.068
7	6	3.8	0.066

As we had seen in Table 3. The average length of boiled potato was 3.5cm. So we assume a space of 5cm to be taken by boiled potato, any clearance could be adjusted by varying the size of the Potato stack and maintaining the distance. We are following the gumball mechanism and we first design a grooved disk.

The size similar to a boiled potato is removed from the disc so that the Potato could easily be put in and without much further disturbance could move along till its falls down by virtue of its orientation. The thickness of the disc is kept at 80% of the max thickness of the potato to prevent it from toppling off and falling into the side spaces. To prevent very close pocket intersections and weaken the webbing, the overall diameter is kept at 15cm.

The sharp edges at the corners are provided with a small fillet of radius 5mm to prevent its sharp edges from breaking the light Puris while counting them or separating them from the stack. A smooth contour ensures easy inflow and outflow of the Puris

Table 4 Observation of rpm values that suit the functioning of the discrete boiled potato counting

Sl. No	RPM of motor	Observation
1	200	Very fast, blocks way and no potato falls
2	100	Fast and mechanism blocked
3	50	Moderately fast and little movement is seen before blocked
4	40	Speed is considerable. 1 potato passed
5	30	Speed is good. Blocking of potato is still an issue
6	20	Speed is best. No blocking

6.6 Design of Quantified Spice transfer

The Spices are stored in plastic cylinders. For the quantization several techniques were observed and finally a sliding valve mechanism was selected. An elliptical disk of a required dimension has been made. One of its centers shall coincide with the center of the narrow opening of the funnel at the end of the storage mouth. The diameter of the ellipse is dependent of the diameter of the narrow opening of the funnel such that at the closed condition, the funnel is completely closed. The other center of the ellipse coincided with the center of servo motor which is attached to it.

A servomotor, specifically, is a rotary actuator which allows the precise control of velocity, angular position and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires the presence of a relatively erudite controller and often a devoted module designed specifically to be used with servomotors.

Table 5 observations for quantization of spice flow

Module	**Delay of salt valve (in milliseconds)**	**Delay of Chilly valve (in milliseconds)**
Low	2000	1500
Medium	2000	2000
Chilly	2500	3000
Very chilly	3000	3500

6.7 Design of Integration system

A network of plastic slides are attached that flows the food items from one system to another. Apart from this, there are basically 2 main features of the integration system.

6.7.1 Design of Conveyor

Due to lack of availability of customized conveyor belt, we design a conveyor belt that suits our purpose and take the Puri from output of puri counter to the punching and feeding mechanism.

Since we are making a conveyor and seeing the availability of the belts at hand, we take a double belt pulley and use a double motor belt drive system. The double motor would ensure that the tension in both the belts is mentioned else which would have created a slack in the upper belt which would make it difficult for the Puris to travel and might result in toppling over or sidewise fall.

Apparently we also need to fix the degree of translation in the 3 direction. Inorder to do so, we shall be attaching small wooden plates of 2cm height, 5cm length and 0.5cm thickness at regular intervals 6cm to prevent the motion of the puri in x direction while travelling in the belt as well as during the piercing mechanism. The 2 flat plates on the either side of the belt would prevent the y direction translation. The belt floor and the absence of upward force would prevent any motion in the Z direction.

Length of the Pulley be L_o.

d_L = diameter of larger pulley

d_S = diameter of smaller pulley

α_s = angle of wrap of larger pulley

α_L = angle of wrap of smaller pulley

C= distance between center

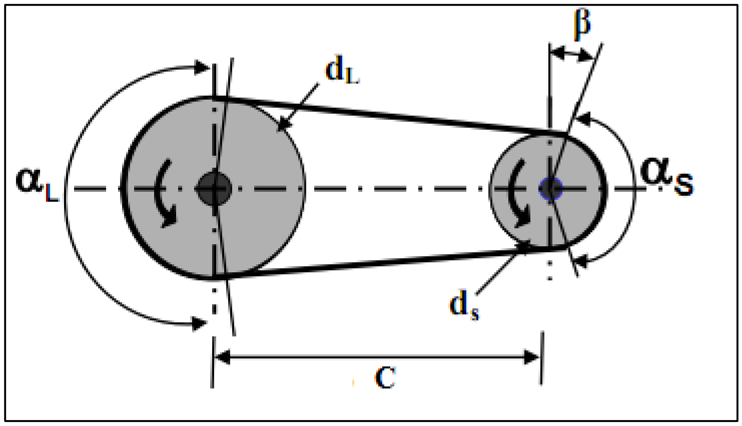


Figure 8 Open belt drive

Our d_L and d_S have equal value which is 6cm and our length of open belt is also fixed since it is bought from market directly.

By simple geometry we can establish that

$$L_o = \frac{\pi}{2}(d_L + d_S) + 2C + (dL - dS)^2/4C$$

$$L_o = 103cm$$

103cm = 18.85 cm + 2C + 0

C = 42cm

2stepper motors are attached to the 2 pulleys at the two ends which shall allow us the benefit of giving step wise rotation. Thus we can stop, stall and work throughout the belt as per our convenience.

6.7.2 Design of Interconnection

Table 6 List of motors under operation

Motor	Use	Specification	Quantity
DC geared motor	Quick return mechanism	12V, 200rpm working at 60% rating	1
DC geared motor	Spider of Masala swipe	12V, 60rpm working at 50% rating	1
DC geared motor	Mechanical Counting	12V,60rpm working at 33.33% rating	2
High torque DC geared motor	Masala Maker	12V, 300rpm	1
Stepper Motor	Conveyor belt of integration system	12V	2
Servo Motor	Masala Quantization	15.5kg/cm at 4.8V, 17kg/cm at 6V	Depends on the number of spice module (here =2)

We shall be using a minimum of 9 motors, 1 solenoid valve and 1 coin actuator mechanism. To synchronize the working of all of the motors together and the working of the whole as 1 unit, we would incorporate all as one part into an Arduino mega controller.

7. Results and Discussion

We first look into the results of the critical structural parts in ASNYS 13.0 where we expect failure could be present. Several analysis with varying loads have been performed.

1) <u>Load of Boiled Potato Stack and its effect on the disc as well as the motor shaft holding it.</u>

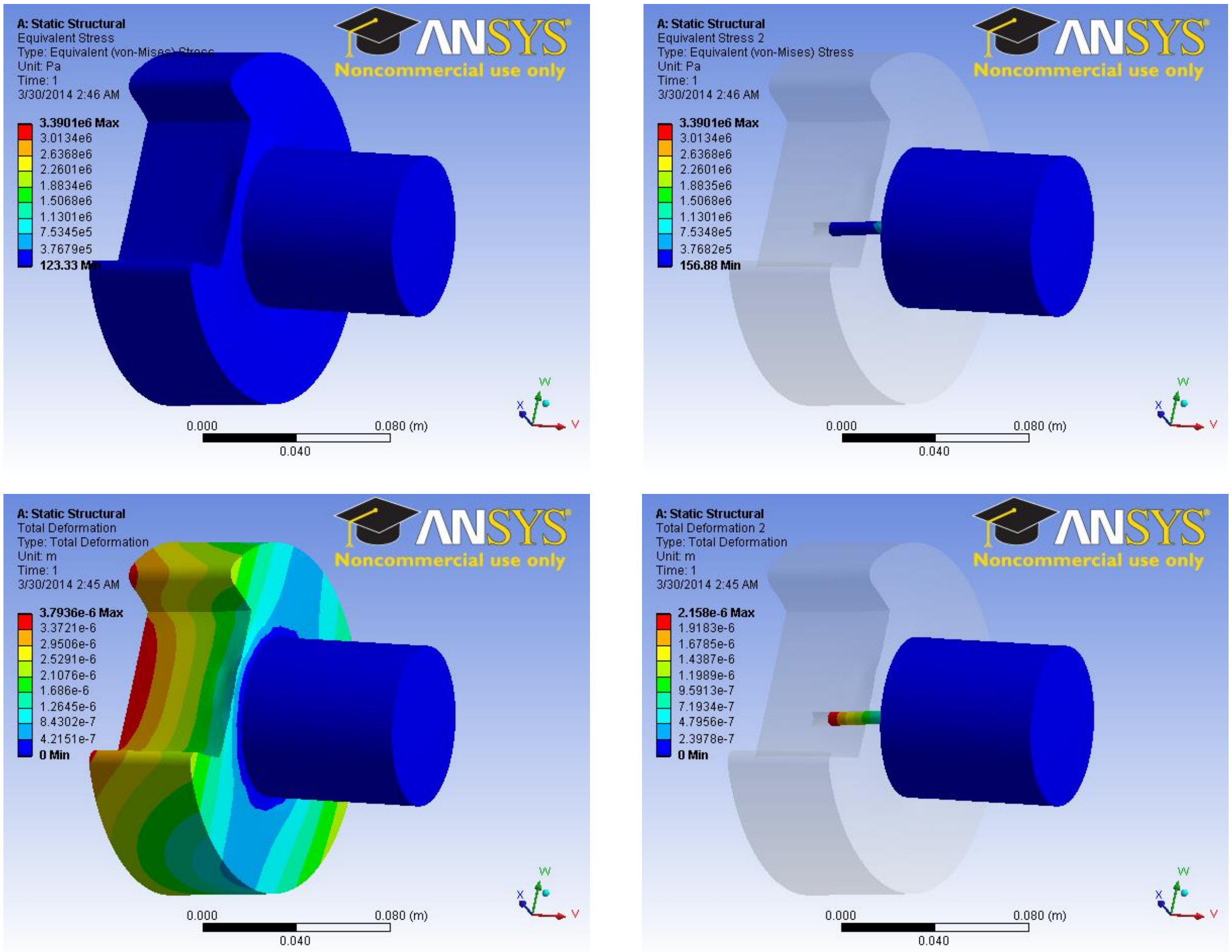


Figure 9. Analysis for 10kg load for Boiled potato counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

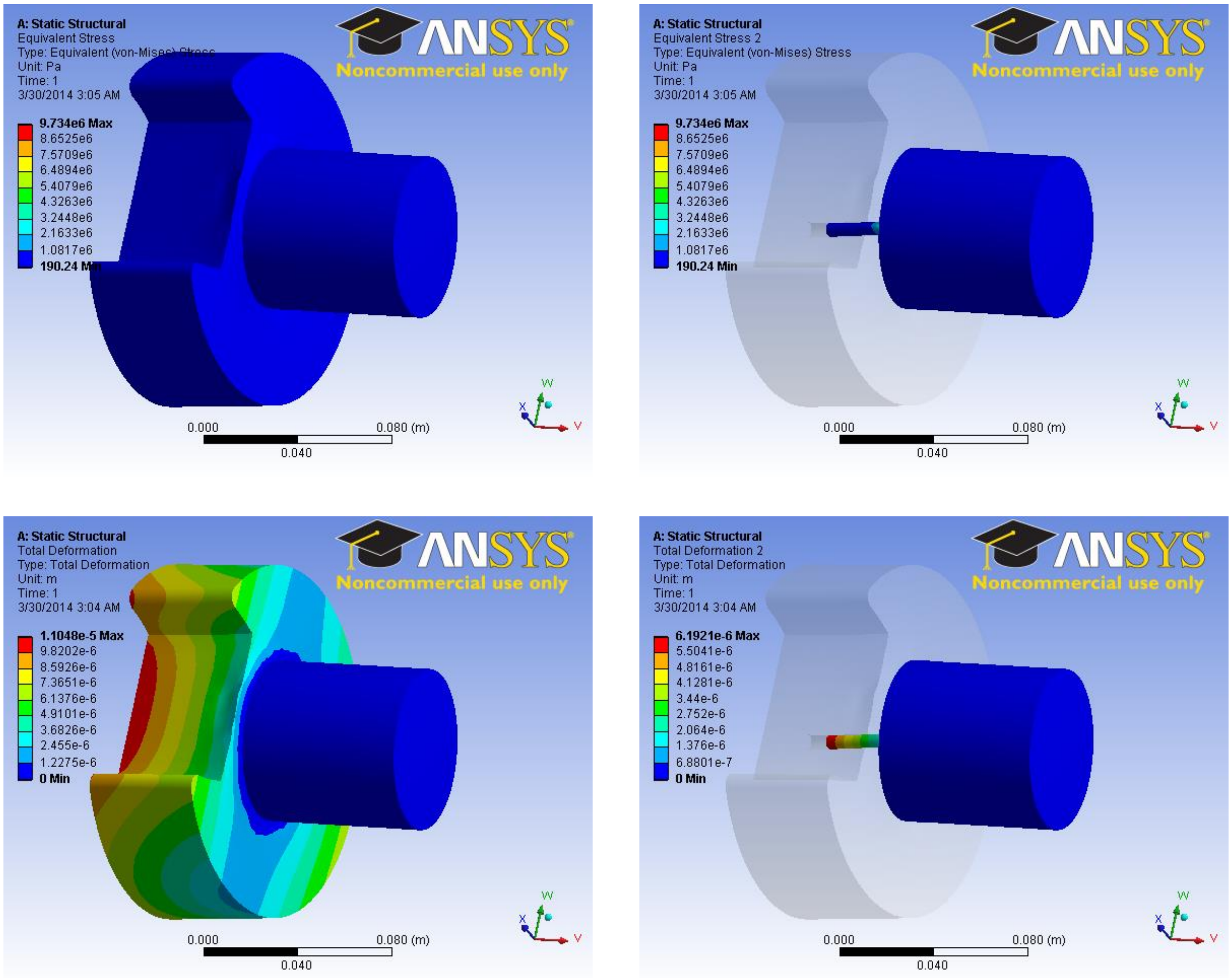


Figure 10. Analysis for 20kg load for Boiled potato counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

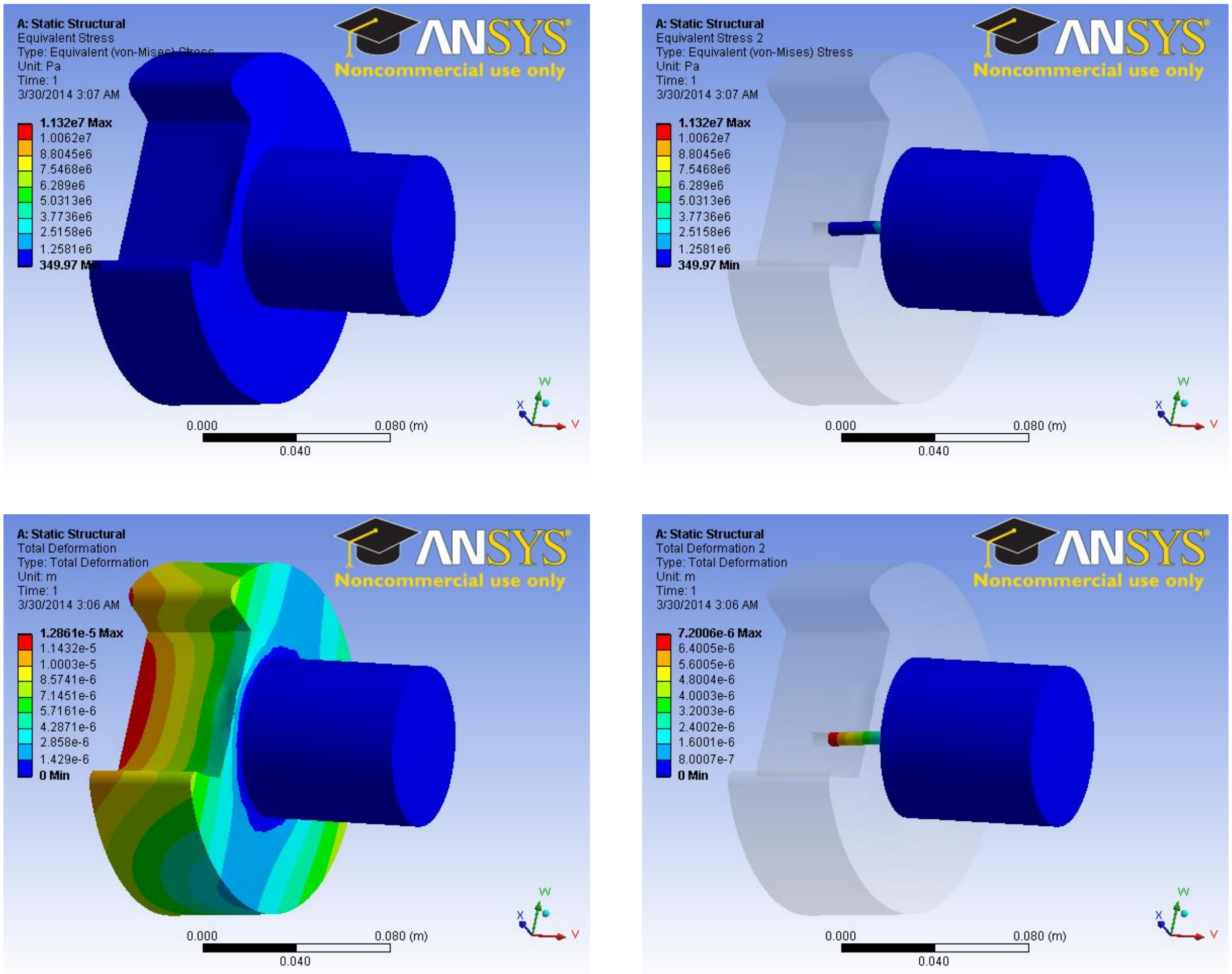


Figure 11. Analysis for 30kg load for Boiled potato counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

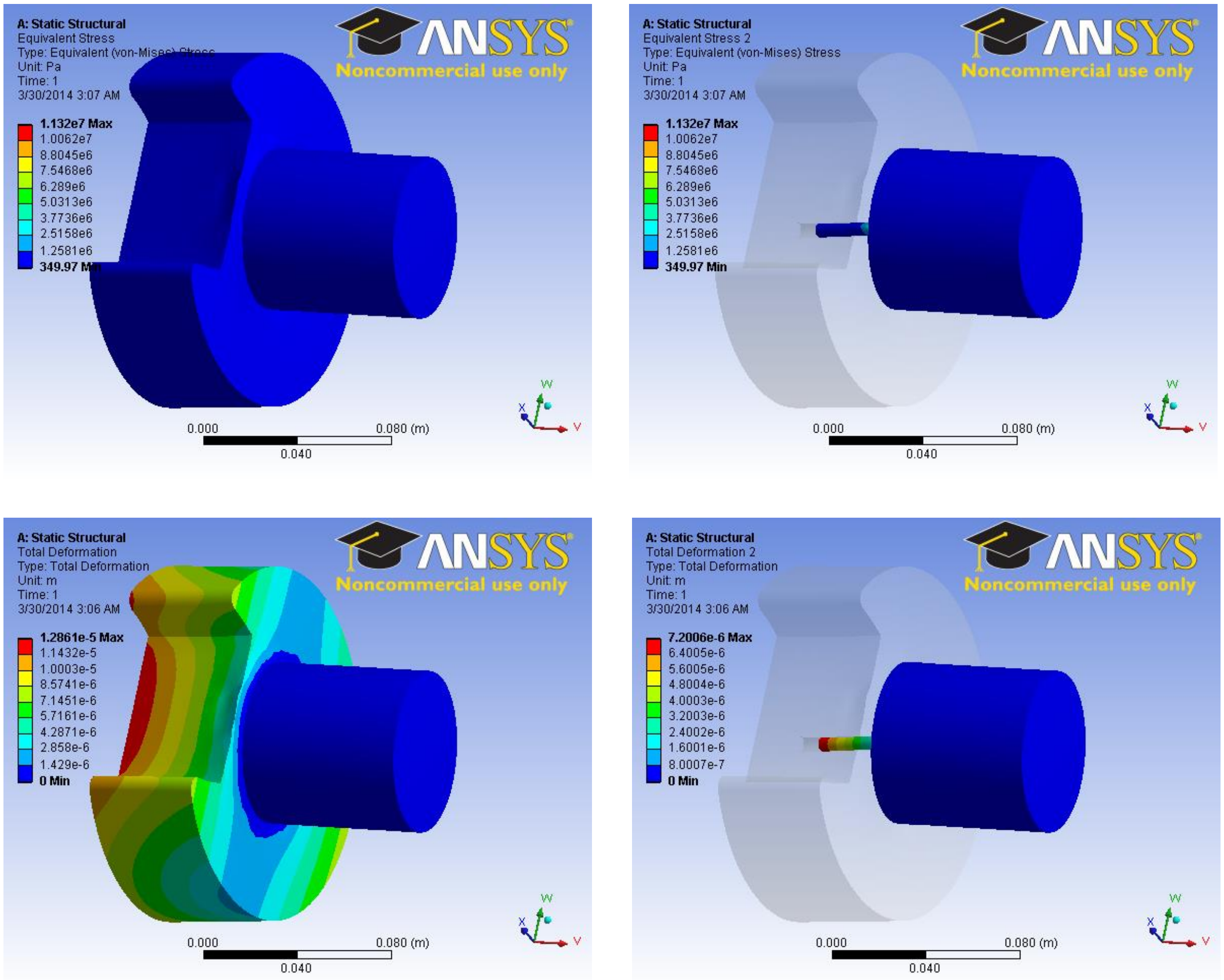


Figure 12. Analysis for 35kg load for Boiled potato counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

Table 7. Effect of varying load on boiled potato counting mechanism

Load	**Total Deformation of whole arrangement**	**Total Deformation of shaft**	**Equivalent (Von misses) stress**	**Equivalent (Von misses) stress of shaft**
10	Order of 10^{-5}, could be neglected	Order of 10^{-6} so neglected	Negligible almost zero	Factor of safety of 60
20	Order of 10^{-5}, could be neglected	Order of 10^{-6} so neglected	Negligible almost zero	Factor of safety of 31
30	Order of 10^{-5}, could be neglected	Order of 10^{-6} so neglected	Negligible almost zero	Factor of safety of 21
35	Order of 10^{-5}, could be neglected	Order of 10^{-6} so neglected	Negligible almost zero	Factor of safety of 18

Since no effect on the shaft of motor has been observed. Yet in order to reduce its weight, holes of varying diameter were made in the block.

2) <u>Load of Puri Stack and its effect on the disc as well as the motor shaft holding it.</u>

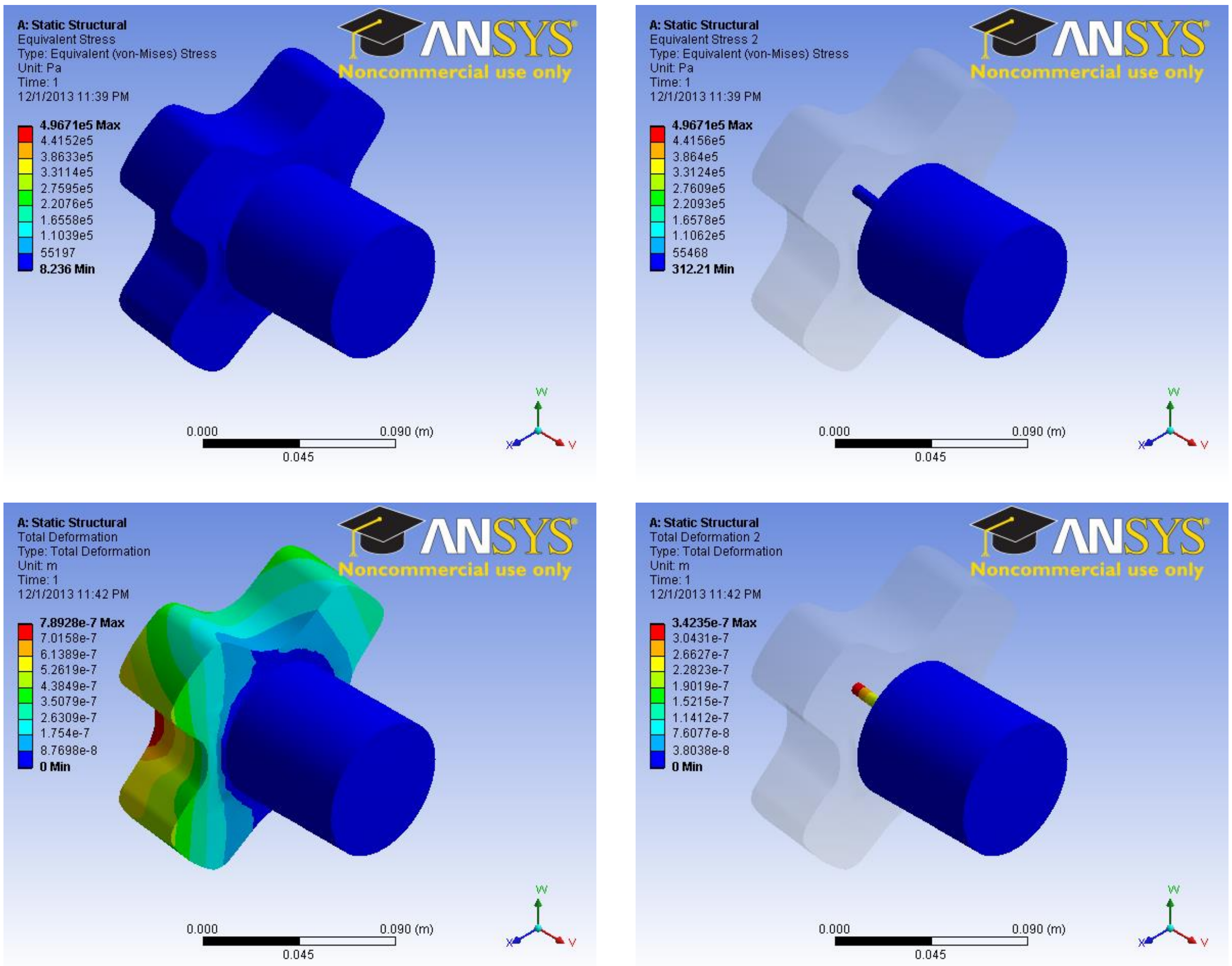


Figure 14Analysis for 1.5kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

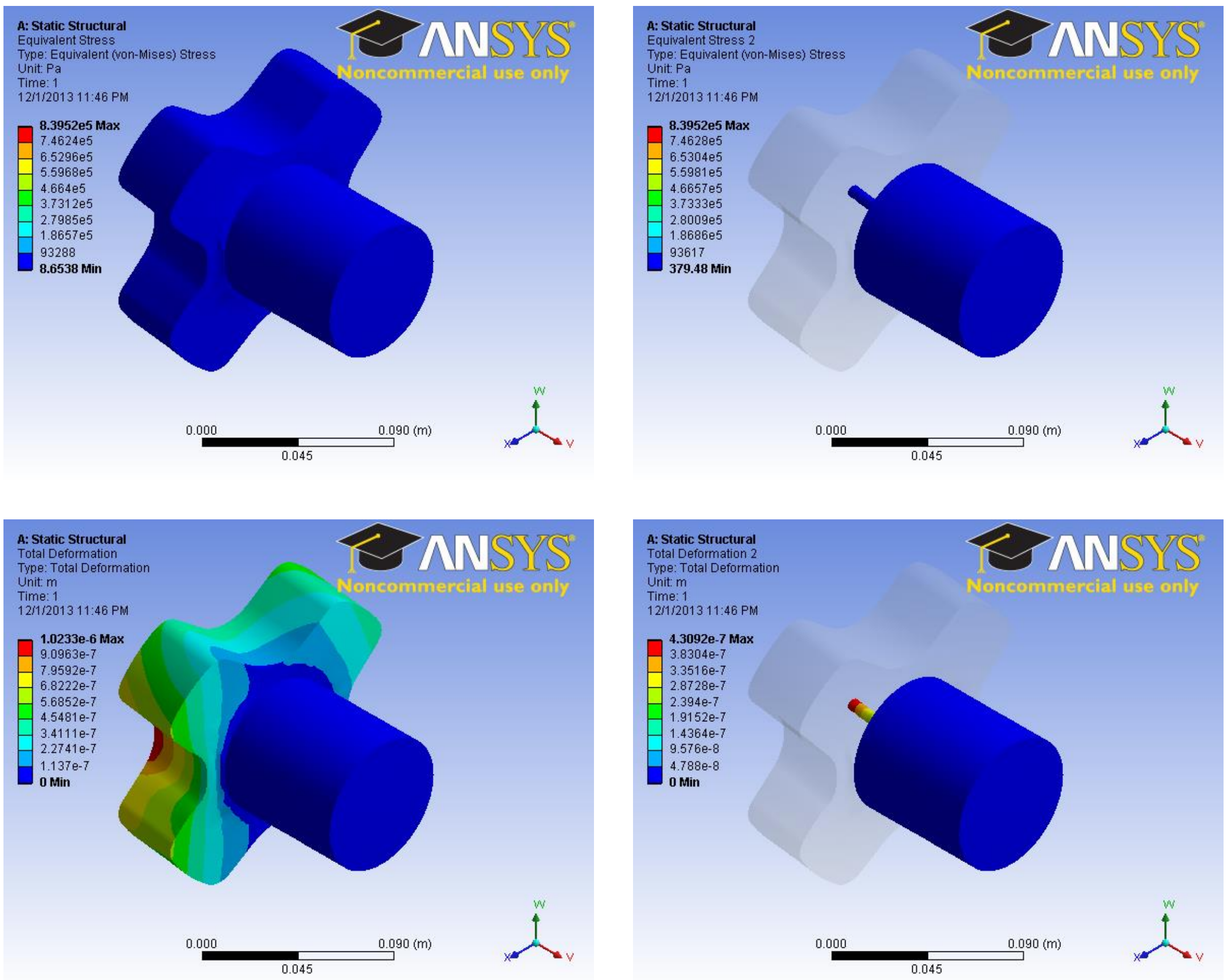


Figure 15Analysis for 2kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

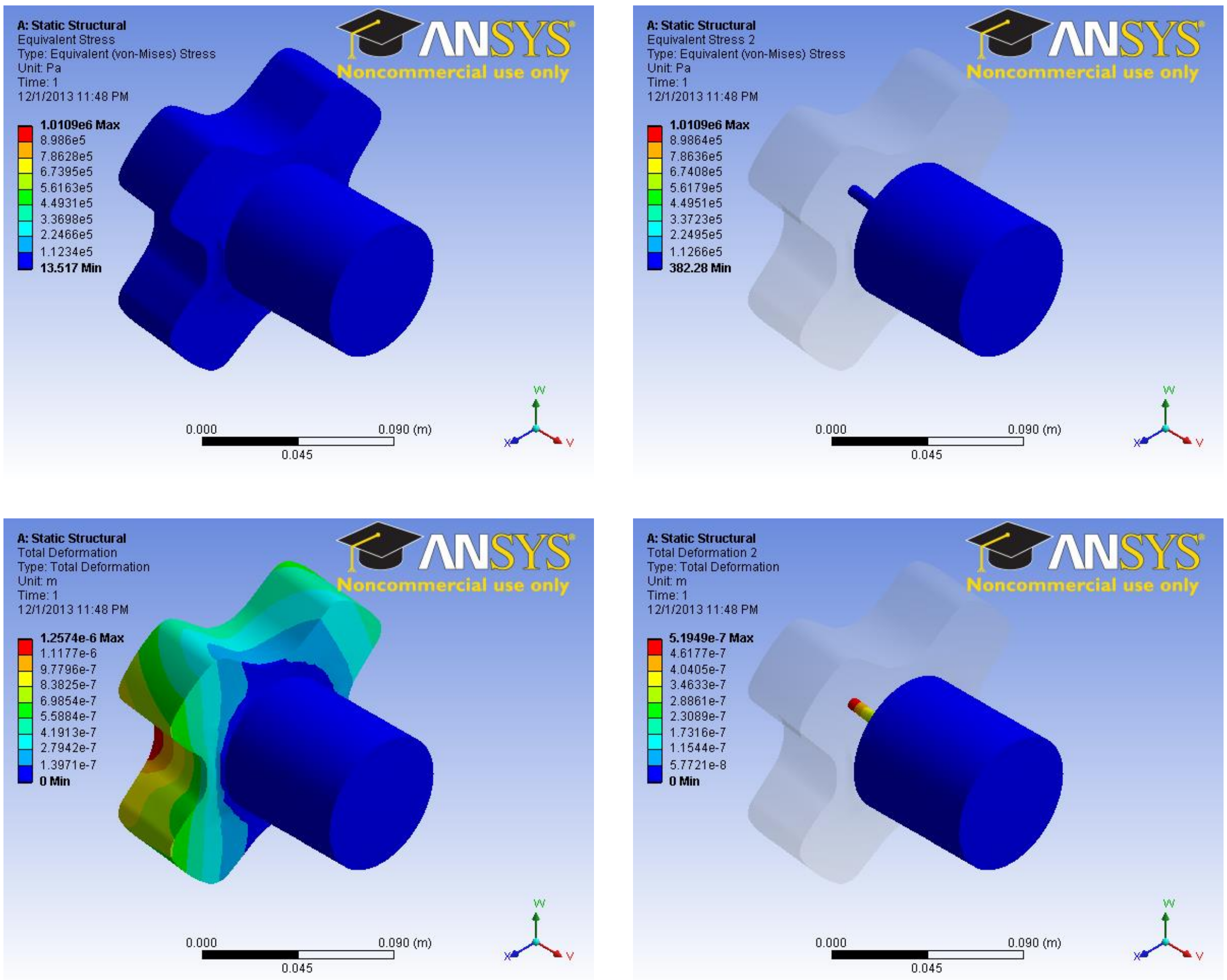


Figure 16 Analysis for 2.5kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

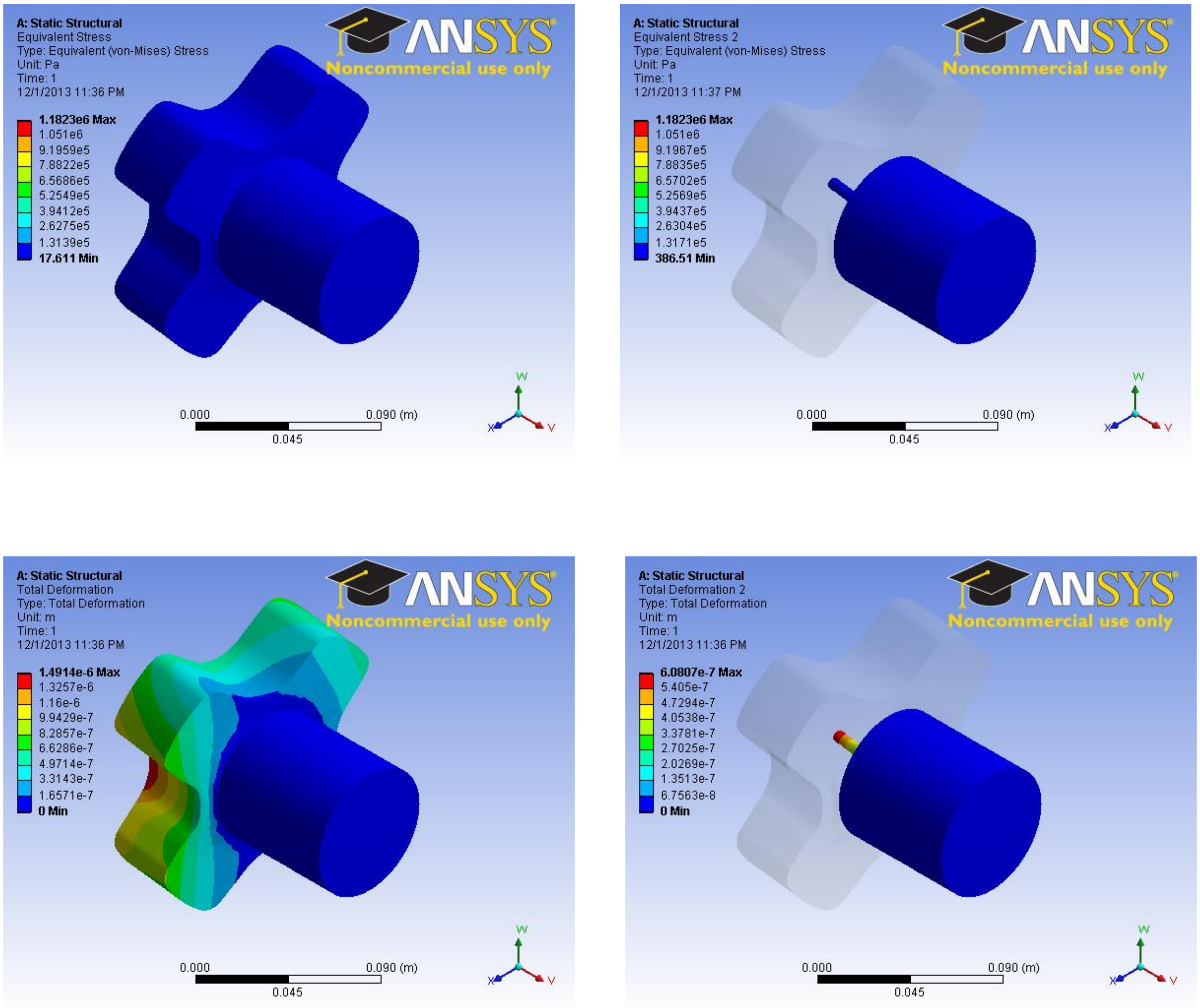


Figure 17 Analysis for 1.5kg load for Puri counter. Left top: static structural of the body, Right top: static structural of the shaft, Left bottom: Total deformation of the body, Right bottom: Total deformation of the shaft

Table 8 Effect of varying load on Puri counting mechanism

Load	**Total Deformation of whole arrangement**	**Total Deformation of shaft**	**Equivalent (Von misses) stress**	**Equivalent (Von misses) stress of shaft**
1.50	Order of 10^{-6}, could be neglected	Order of 10^{-7} so neglected	Negligible almost zero	Factor of safety of 306
2.0	Order of 10^{-6}, could be neglected	Order of 10^{-7} so neglected	Negligible almost zero	Factor of safety of 247
2.50	Order of 10^{-6}, could be neglected	Order of 10^{-7} so neglected	Negligible almost zero	Factor of safety of 205
3.0	Order of 10^{-6}, could be neglected	Order of 10^{-7} so neglected	Negligible almost zero	Factor of safety of 174

Since no effect on the shaft of motor has been observed. Yet in order to reduce its weight, holes of varying diameter were made in the block.

We divide the whole part into 2 floors, the 1st floor houses the Counting mechanisms (Puri and Potato. Puris and Potatoes are almost of similar lateral dimensions but boiled potatoes are cylindrical in shape and heavy while Puris are extremely light as well as spherical in shape.

The counting mechanism devised to count boiled potatoes as well as Puri from the storage cylinders. This ensures that the required number of objects fall into the next system for processing before converting into final product.

The 2nd floor basically houses the ultimate system which consist of the Masala maker, Masala transfer system, feeding and punching mechanism, spice quantization and integration.

Since the Masala maker, masala transfer system as well as the feeding and punching mechanism are joined into one unit. They become the largest of all unit and all other units are placed as per their position. So the main frame is placed keeping them as the nodal center.

Our concept worked well and with the help of the guide attached to the upper cover plate as well as the translator clearance left at the 2nd link shown, a proper quick return mechanism was made. The speed was found to be sufficient to pierce holes and the holes made didn't damage the puri and when the masala fell, it gracefully entered the Puri.

The Masala Maker's hopper had a huge base which caused certain instability in the cover plate and with a high torque blade running at 300rpm could have damaged the bond. Thus to improve their strength, seal was used. An overhead arrangement had to be made to accommodate the motor which shall be connected to the blade. The blade was also connected by several wooden strips with the main shaft to give it lateral strength. This prevented any potato to come in between the blade wires and get stuck. Moreover heavy torque and the high rpm did the magic.

In the masala transfer mechanism, the cover plates are stuck with super glue to their metal casings. The spider is connected at the bottom by the DC motor which is clamped to one of the main frames. The Spider works in synchronization with the quick return mechanism to punch the masala through the plates and prevent the hitting of the blades.

The conveyor designed also survived the tension due to the belts of the belt drive. Thus allowing the transfer of Puris from the exit of puri counting mechanism to its feeding and punching zone.

Thus by combining all the mechanisms we devise the indigenously automated gupchup Machine.

7. Conclusion

In this work, the automation of a popular snack has been achieved. We believe that the product is indigenous since the GupChup made by this method shall suit the taste of the locality from which the survey has been made. There have been several parameters and design non constraints that has been left out to allow more and more research work on this particular device which shall spawn up more cheaper, more hygienic and better technology in the future. The fabrication of the device could be made with the above set of data and information described. Due to intention for application of Patent, the complete details of the fabrication and the interconnection as well as the synchronization has not been described. We believe that this product has a huge industrial application as the food industry has been booming since the past few years. The overwhelming popularity of the GupChups in the country and even in several places abroad leads the foundation of an entrepreneurial venture of selling the Indian snack abroad as had been done before via automatic samosa machine and automatic dosa machine. Such ventures would provide more and more employment opportunities for people in India and add to the foreign revenue generated by the country.

References

[1] R.S.Khurmi and J.K.Gupta, ―Theory of Machines‖, S. Chand Publications, 14th Edition, 2007, pp. 108

[2] Fully-automatic espresso coffee machine

http://www.wegausa.com/_docs/pdfs/technical-manuals/technical_manual_super.pdf

[3] Le Cube Service Manual coffee Machine

http://www.computersolutions.cn/blog/wp-content/uploads/2011/09/Krups-Cube-Nespresso-Service-Manual-xn5005-manual.pdf

[4] Gumball Machine

http://grathio.com/2010/05/secret_knock_detecting_gumball_machine/

[5] Tv9 Gujarat - Watch how delicious Pani Puri is a threat to your life part 1 & 2 -YouTube

http://www.youtube.com/watch?v=92iZCp75Mpg

http://www.youtube.com/watch?v=f3fJyQgpy84

[6] Semi-Automatic Pani Puri Machine

http://202.131.126.226/memc/file.php/1/me_project/5._Semi_Automatic_Pani_puri_Machine.pdf